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State of Washington

Better Brakes Baseline Report

Updated Brake Friction Material Release Estimates for Copper, Nickel, Zinc, and Antimony

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Better Brakes Baseline

Updated Brake Friction Material Release Estimates for Copper, Nickel, Zinc, and Antimony

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Links to Most Recent Data

This report is based on data that was reported as of June 20, 2013. Ecology receives ongoing reports from manufacturers each quarter. These reports may include updated baseline information and ongoing certification data. Ecology will update the information as new reports come in. For the most recent data please see the following:

- List of Certified Edge Codes
- Complete Baseline Dataset
- Baseline Averages for Copper, Nickel, Zinc, and Antimony
- List of Manufacturers that Have Submitted Baseline Data
- Number of Formulas Reporting Baseline Information
- Histogram – Baseline Copper Concentrations in Light Duty Friction Formulas
- Histogram – Baseline Copper Concentrations in Heavy Duty Friction Formulas
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- Histogram – Baseline Antimony Concentrations in Heavy Duty Friction Formulas

Executive Summary

Each time a driver uses their brakes a small amount of brake wear is released to the environment. Once this wear debris is released it is deposited on the road where it may be washed into streams and rivers. Many brakes pads and shoes contain copper and other metals that are toxic to many aquatic organisms. Salmon are especially susceptible to copper. Even trace amounts can hinder their ability to smell, affecting their ability to avoid predators and find their spawning streams. Brakes are one of the largest sources of copper pollution in urban areas and can account for up to half of the copper entering streams and rivers.

In 2010, Washington State passed the Better Brakes Law. This law bans the use of asbestos, lead, several heavy metals, and provides for a phase-out for copper. The Better Brakes Law is the first of its type and it promises to dramatically reduce the environmental impacts of brake friction materials. All brakes manufactured after 2015, must be certified and marked with an environmental certification mark before they may be sold in Washington State.

Under the Better Brakes Law manufacturers are required to report baseline information on the concentrations of copper, nickel, zinc, and antimony in their products. Using this data Ecology estimates that brakes manufactured in 2021 will release about 90 percent less copper than those currently on the market.

Recent data estimates of the amount of copper released from brake friction materials to the Puget Sound basin are higher than previously published. Ecology now estimates that between 69 and 80 metric tons of copper are released to the Puget Sound basin each year. Statewide these estimates are between 104 and 121 metric tons of copper.

Ecology believes that we have received baseline reports from manufacturers on the majority of formulas sold in Washington State and that most manufactures will comply with our state's law for all brakes sold in the United States. The Better Brakes Law will also likely reduce the environmental impact on brakes sold around the globe. Ecology received baseline reports from companies in North America, South America, Asia, and Europe. We expect that these companies will also certify their products to meet the new environmental requirements.

The most recent information is available on our Better Brakes Baseline Report website.

The baseline report will review how data was collected, discuss the results, and provide updated release estimates for the amount of copper, nickel, zinc, and antimony that are released to Washington State. This baseline data will be used to measure the success and progress of the Better Brakes Law.

Background Information

Automobile brakes were first identified as a significant source of copper pollution in the 1990's. Shortly after this problem was identified, a team of brake manufacturers, government, and water quality interests came together to form The Brake Pad Partnership (BPP). The BPP was a collaborative, consensus-based group. Its goals were to study the problem and identify potential solutions.

The BPP conducted a detailed analysis of the amount of copper released from brake friction material to the San Francisco Bay. This analysis included estimates of copper releases from both brake and non-brake sources, brake wear debris characterization, and computer modeling of copper released from brakes. The estimates made by the BPP relied on a variety of data sources including studies of dust in tunnels and various other efforts to test brakes for their copper content. The BPP also created a voluntary reporting program in which manufacturers reported copper use in brake friction material for the most popular new vehicles sold in the United States. This reporting provided valuable data on the how much copper was used in original equipment brakes. However, while some sampling had been done on aftermarket brake parts, little was known about copper use in aftermarket parts.

Ecology used some of the data generated by the BPP to publish estimates of copper released from brake friction materials to Puget Sound as part of the Puget Sound Toxics Assessment Study. This study concluded that brake friction materials release approximately 37 metric tons of copper each year to the Puget Sound basin.

The work of the BPP ultimately lead to the adoption of laws in Washington and California phasing copper out of automobile brakes. These laws also ban the use of asbestos, lead, and several heavy metals. Washington State's law requiring a phase-out of copper is known as the Better Brakes Law - Chapter 70.285 RCW[1]. It also requires manufactures of brake friction material to provide a baseline report on the concentration of copper, nickel, zinc, and antimony in products sold in Washington State. While the data provided as part of this requirement does have limitations, it contains the broadest data available on the concentrations of these elements in brake friction materials to date.

To achieve a more accurate picture of the amount of copper released from brake friction materials, Ecology updated its release estimates using the data provided as part of baseline reporting under the Better Brakes Law. Ecology relied on the same general methodology that was used previously as part of the Toxic Assessment Study. A detailed description of this method may be found in Appendix E, "Methodology Used to Estimate Metals Releases from Vehicle Brake Pads and Tire Wear," from the Phase 3 Toxic Assessment Study report, "Primary Sources of Selected Toxic Chemicals and Quantities Released in the Puget Sound Basin.[2]" (This will be referred to as "Appendix E" throughout this report.)

The Better Brakes Law also directs Ecology to use this data to establish baseline concentrations of copper, nickel, zinc, and antimony in brake friction material. Ecology is directed to monitor the levels of nickel, zinc, and antimony. If the levels increase by more than fifty percent, Ecology is to determine if these materials may be impacting human health or the environment. If so, Ecology is to consider recommending limits on these constituents as well.

[1] Revised Code of Washington
[2] Department of Ecology publication #11-03-024, https://fortress.wa.gov/ecy/publications/SummaryPages/1103024.html

This report describes how baseline data was collected, discusses some of the limitations of this dataset, explains how our release estimates were updated, outlines anticipated reductions of copper releases as a result of the Better Brakes Law, and establishes a baseline to evaluate the success of the law.

About Baseline Reporting

Under the Better Brakes Law and its accompanying regulations, Chapter 173-901 WAC[3], manufacturers of brake friction material are required to report:

- Basic contact information.
- The concentrations of copper, nickel, zinc, and antimony in each brake friction material manufactured during 2011 and sold in Washington State.
- If the material was for use on heavy-duty commercial vehicles, light-duty vehicles, or both.

For a more detailed description of the reporting requirements please see WAC 173-901-110.

When reporting baseline information, manufacturers could identify each formula by a code of their choosing. While some manufacturers chose to provide the actual Edge Code (a unique code marked on brakes) for each formula, most chose to report using an assigned code that could not be linked to a specific product. For example: 1, 2, or 3.

The reported data was based on manufacturer knowledge of their production processes and formulations. Manufacturers were not required to perform laboratory testing for the baseline report. However in the future they must perform laboratory testing as part of the process to certify brake friction material. The results of laboratory testing performed on each Edge Code offered for sale in Washington State, must be reported to Ecology along with a signed statement that the brakes meet the requirements of the law.

Ecology developed regulations and informal guidance to aid manufacturers in meeting these reporting requirements. Important elements of the regulations and guidance include:

- Manufacturers that did not know which states their products were sold in were advised to report on all products sold in North America. Ecology believes most manufacturers reported for all products sold in North America.

- Average concentration should be reported, based on the amount of the element present in the brake friction material. For example: only 79.9 percent of the amount of copper oxide (CuO) used in a brake friction material formula would be reported as copper.

- When brass was used and the precise concentration of copper and zinc was not known, manufacturers were directed to report seventy percent copper and thirty percent zinc for any brass used in the formula.

- Manufactures were advised to be as accurate as possible, but that some level of estimation may be appropriate.

[3] Washington Administrative Code

- Manufacturers were advised to use their best judgment when determining which type of vehicle the brakes were used on and that appropriate methods could be by vehicle weight or by the safety standards the brakes must meet.

- Ecology informed manufacturers that while they must provide a baseline report before they may certify their products, Ecology would not take enforcement actions against companies that did not file baseline reports by the reporting deadline.

All reporting was facilitated through a third party registrar, also known as a third party testing certification agency. This entity registers and certifies brake friction materials, then transmits baseline reports and certification information to Ecology. Ecology received baseline reports submitted by two organizations acting as registrars. Each registrar had their own process and forms for collecting the required information, but reported to Ecology in a consistent electronic format.

Ecology believes that the baseline report covers the majority of the brake manufacturing industry and that most manufacturers will comply with the requirements of California and Washington. As part of the rule development process Ecology conducted an estimate of the number of manufacturers and the number of brake friction formulas that are sold in Washington State. (Details regarding these estimates and how they were developed may be found in the Final Cost Benefit Analyses for the better brakes rules.) We estimated that there are about 150 manufacturers making about 1500 brake friction formulas. At the time of publication we received reports from 33 manufacturers on 1142 formulas. Based on these estimates, Ecology believes that the baseline reports received so far represent a majority of the marketplace. We also expect that more companies will report in the near future. The most recent updated information will be on the Better Brakes Baseline Report website.

Data Limitations

While the Better Brakes Law provides a framework for the data provided to Ecology, the exact content of the baseline reports was developed through rule making. Ecology used a negotiated rule-making process to develop rules to implement the Better Brakes Law. Negotiated rule making is a process in which interested parties work together to develop rules using consensus. Ecology ultimately reached consensus on the rules with all interested parties including brake and auto manufacturers, environmental groups, brake retailers, and installers. As a result the data reported balances a wide variety of interests including ease of reporting, protection of confidential business information, and the need to get information that can reliably be used to monitor the effectiveness of the law. Listed below are some of the important limitations of the data reported as part of baseline reporting:

1. All data is self reported by manufacturers and there are limited accountability mechanisms. There is no way to tie a specific baseline report on a formula to a specific product in the marketplace, therefore there is no way to verify the accuracy of the reported information. In the future, manufactures will be required to conduct laboratory testing to certify their products and report the results to Ecology.

2. The data may contain some degree of estimation. While many manufacturers may know the precise concentrations of each element in each of their formulas, anecdotal evidence suggests that other manufacturers may need to rely on suppliers' Material Safety Data Sheets (MSDSs) to determine the concentrations of these elements in their base ingredients. MSDSs often only report on ingredients that require special handling or disposal or they report concentrations in

ranges as opposed to providing precise values. Ecology advised manufacturers to be as accurate as possible when reporting, but that some degree of estimation was appropriate when reporting.

3. Ecology did not precisely define "heavy-duty commercial vehicles" or "light-duty vehicles." Each manufacturer may track these slightly differently. For example one manufacture might classify and track a material based on the weight class of the vehicle it is intended for, while another may track it by the federal safety standard the product must meet. Given this variability, Ecology left this decision to each manufacturer.

4. The usefulness of the data in estimating the amount of copper, nickel, zinc, and antimony released to the environment is limited by the lack of information about the production volumes of each formula or the vehicles the formulas are used on. Some formulas may be used rarely in Washington while others may be very common. Without this detailed information a more accurate estimate of the amount of these elements released from brake friction materials is difficult. For our estimates we assume that each formula has an equal chance of being used in Washington State.

Release Estimates

The same method that Ecology previously used to estimate the amount of copper released from brake pads will be used to update the estimates. A detailed description of the method and how it was developed may be found in Appendix E.

This report will:

- Provide a brief summary of the estimation method.
- Identify the minor differences in how the current estimate was developed.
- Present the analysis of the data provided as part of baseline reporting.
- Provide updated estimates of the amount of copper, nickel, zinc and antimony released from brake friction materials in Washington State.

Summary of the Estimation Method

The method used to estimate the amount of each element released from brake friction materials is relatively simple. First the estimated number of vehicle kilometers traveled (VKT) in Washington are multiplied by the estimated wear rate of brake materials. Then the result is multiplied by the estimated concentration of copper, nickel, zinc, and antimony in brake friction materials. This yields an estimate of the total amount of copper, nickel, zinc, and antimony released from brake friction materials in Washington State.

Vehicle Kilometers Traveled

The Washington State Department of Transportation (WSDOT) tracks statewide and county estimates of VKT and estimates of the proportion of VKT that are driven by various types of vehicles, on various types of road. This data was obtained from WSDOT for 2011, the same report year as baseline reporting. The data Ecology obtained may be found in Appendix A.

WSDOT tracks VKT for six types of vehicles. They also provide estimates of the proportion of VKT traveled by each type of vehicle, both as a statewide average and on six types of roads. WSDOT advised Ecology to use the statewide averages for our estimates.

Ecology calculated both a Puget Sound and statewide estimate of copper, nickel, zinc, and antimony released from brake pads. The Puget Sound estimate was derived using the VKT data from the counties that border Puget Sound.

Vehicle Kilometers Traveled in Washington State

	Statewide VKT (km/yr)	Puget Sound VKT (km/yr)
Motorcycles	320,867,240	210,277,961
Passenger Cars (2 axle, 4 tire)	58,449,176,448	38,304,233,300
Light Trucks (2 axle, 4 tire)	23,448,061,140	15,366,512,566
Buses	240,192,048	157,408,074
Single-Unit Trucks	4,335,374,795	2,841,155,645
Combination Trucks	4,882,682,630	3,199,829,766
Total	**91,676,354,301**	**60,079,417,312**

Brake Friction Material Wear Rates

Ecology previously generated estimates for brake friction material wear rates for each of the six vehicle types WSDOT has VKT data on as part of the Puget Sound Toxics Assessment Study. These estimated wear rates were used when updating the release estimates. For a description of how these rates were developed see Appendix E.

	Wear Rate (mg/km)
Motorcycle	3
Passenger Cars (2 axle, 4 tire)	16
Light Trucks (2 axle, 4 tire)	16
Buses	110
Single-Unit Trucks	129
Combination Trucks	245

There is limited data available about average wear rates for brake friction materials and estimating wear rates on a per kilometer basis is difficult at best. In our estimates wear rates are the variable with the highest degree of uncertainty and they have a considerable impact in the overall estimate of releases from brake friction materials. For a more thorough discussion of these uncertainties see Appendix E.

Concentrations of Copper and Other Elements in Brake Friction Material

Baseline data provides insight into the concentrations of copper, nickel, zinc, and antimony in brake friction material sold in Washington State. To derive estimate average concentrations for each element, Ecology initially calculated the mean concentration of each element in light- and heavy-duty friction materials. Formulas that were reported as used in both applications were included in the mean for both light- and heavy-duty brakes.

These initial estimates were shared with members of the Society of Automotive Engineers (SAE) Environmental Brake Taskforce. Ecology noted that the averages for heavy-duty brakes were considerably higher than expected, based on previous studies. Members of the task force subsequently advised Ecology that heavy-duty brakes with more than five percent copper were most likely heavy-duty disk brakes, which are rare in the United States. The Brake Pad Partnership estimated that less than five percent of heavy-duty brakes are disk brakes. The remaining percentage is made up of the more

common drum brakes. For the purposes of their copper release estimates, they assumed that disk brakes were used on three percent of heavy-duty vehicles. We also used this three percent figure in our updated release estimates.
Based on this information from heavy-duty brake manufacturers, Ecology recalculated three means for light-duty, heavy-duty drum brakes, and heavy-duty disk brakes. For the purposes of this estimate Ecology assumes that all heavy duty brakes with more than five percent copper are disk brakes – in line with the advice from SAE taskforce members.

Ecology then calculated confidence intervals for each of these means. To do this, Ecology first created histograms of the baseline data and determined that the data did not have a normal distribution. (Histograms of the most recent data are available on Ecology's Better Brakes website.) As a result, Ecology used a technique referred to as *bootstrapping*, which does not assume a normal distribution to calculate confidence intervals. This method is based on random resampling. To briefly explain the bootstrap method and the process we used:

- Ecology randomly resampled the data with replacement, meaning an individual friction formulation may be represented multiple times in each resample - the size of the resample was equal to the original sample.
- The mean was calculated for the resample and stored.
- This process was repeated 10000 times.
- Ninety-nine percent confidence intervals were calculated from the 10,000 stored means for each resample.

This process was used to calculate confidence intervals that were then used to calculate high and low estimates for the average concentrations of copper, nickel, zinc, and antimony in heavy-duty disk brakes, and light- and heavy-duty drum brakes. The following tables show the mean concentrations and the lower and upper confidence intervals for each of the elements.

Copper Concentrations by Weight

	Mean	Lower 99% CI	Upper 99% CI
Light Duty	7.72%	7.21%	8.22%
Heavy Duty - Drum	0.30%	0.20%	0.44%
Heavy Duty - Disk	10.75%	9.58%	12.72%

Nickel Concentrations by Weight

	Mean	Lower 99% CI	Upper 99% CI
Light Duty	<0.01%	0.006%	0.014%
Heavy Duty - Drum	<0.01%	0.003%	0.010%
Heavy Duty - Disk	0.33%	0.02%	0.05%

Zinc Concentrations by Weight

	Mean	Lower 99% CI	Upper 99% CI
Light Duty	0.96%	0.84%	1.09%
Heavy Duty - Drum	0.23%	0.15%	0.32%
Heavy Duty - Disk	1.83%	1.29%	2.53%

Antimony Concentrations by Weight

	Mean	Lower 99% CI	Upper 99% CI
Light Duty	1.25%	1.10%	1.43%
Heavy Duty - Drum	0.18%	0.09%	0.30%
Heavy Duty - Disk	2.94%	2.20%	3.90%

*The numbers in these tables are as of the time of publication. Some manufacturers are still reporting baseline data. The most recent data may always be found on our Better Brakes Baseline Report website.

Calculating Release Estimates

The three variables (VKT, wear rate, and average concentration) were multiplied together to yield low-, mid-, and high-range estimates of the amount of copper, nickel, zinc, and antimony that were released from brake friction materials by each vehicle type in Washington State and in the counties bordering Puget Sound. The results are presented below:

Low Estimate

	Copper (kg/yr)	Zinc (kg/yr)	Nickel (kg/yr)	Antimony (kg/yr)
Statewide Total	104,100	14,200	200	17,700
Puget Sound Total	68,700	9,800	100	11,800

High Estimate

	Copper (kg/yr)	Zinc (kg/yr)	Nickel (kg/yr)	Antimony (kg/yr)
Statewide Total	121,000	20,400	400	25,500
Puget Sound Total	80,000	13,900	200	17,000

Midrange Estimate

	Copper (kg/yr)	Zinc (kg/yr)	Nickel (kg/yr)	Antimony (kg/yr)
Statewide Total	111,200	17,500	200	20,800
Puget Sound Total	73,400	11,500	150	13,900

Midrange Statewide Release Estimates by Vehicle Type

	Copper (kg/yr)	Zinc (kg/yr)	Nickel (kg/yr)	Antimony (kg/yr)
Motorcycles	74	9	0	12
Passenger Cars	72199	8999	87	11735
Light Trucks	28964	3610	34	4708
Buses	78	60	1	48
Single-Unit Trucks	3419	1540	36	1488
Combination Trucks	6493	3295	69	2827

Estimated Releases in 2021

The Better Brakes Law requires that brakes manufactured after 2021 contain less than five percent copper by weight. Ecology also has the authority to implement restrictions on brakes with more than 0.5 percent copper, if brakes containing less than 0.5 percent copper become readily available.

Ecology wanted to estimate the impact of these requirements on the amount of copper that will be released to the environment from brake friction materials in the future. To accomplish this we used the

same general method outlined above and in Appendix E, but we made several assumptions about each of the variables and what they will be in 2021.

First, for the sake of simplicity, we assumed the VKT and wear rate will remain constant and not increase. Historically, VKT increases each year in Washington State and a more accurate estimate would include an estimation of VKT in 2021. It is unknown if changes in brake friction formulations will significantly change wear rates.

The predictions we made rely primarily on assumptions regarding what the average concentrations of copper in brake friction material will be in 2021. To estimate these values we first determined the number of brakes currently in each of the three compliance categories: brakes with greater than five percent copper (high copper), brakes with between 0.5 and five percent copper (low copper), and brakes with less than 0.5 percent copper (no copper). Then we calculated the current mean concentration of copper, nickel, zinc, and antimony in brakes in each of the three compliance categories.

Light Duty - Count of Formulas in Each Compliance Category

Greater than 5% copper	578
Between 0.5% and 5% copper	91
Less than 0.5% copper	354

Heavy Duty - Count of Formulas in Each Compliance Category

Greater than 5% copper	54
Between 0.5% and 5% copper	41
Less than 0.5% copper	202

Light Duty - Mean Concentration in Each Compliance Category

	Cu (% by Wt)	Ni (% by Wt)	Zn (% by Wt)	Sb (% by Wt)
>5% Cu	13.16%	0.01%	1.42%	2.03%
0.5% - 5% Cu	3.16%	<0.01%	0.74%	0.80%
<0.5% Cu	0.01%	<0.01%	0.27%	0.11%

Heavy Duty - Mean Concentration in Each Compliance Category

	Cu (% by Wt)	Ni (% by Wt)	Zn (% by Wt)	Sb (% by Wt)
>5% Cu	10.75%	0.03%	1.83%	2.93%
0.5% - 5% Cu	1.60%	<0.01%	0.60%	0.56%
<0.5% Cu	0.03%	<0.01%	0.16%	0.11%

After calculating these variables we made several assumptions about how formulas in each category will change over time and how these changes will impact the overall average concentration of copper in brakes used on vehicles in Washington State. We assumed that each high-copper formula will be replaced by another formula and that the total number of formulas will remain constant. We assumed that high-copper formulas would be replaced by either the average low-copper formula or the average no-copper formula. We assumed that these replacements would happen at a rate equal to the current proportion of low- to no- copper formulas currently available. For example, if there are 100 no-copper formulas and 200 low-copper formulas, 1/3 of the high-copper formulas would be replaced by a no-copper formula and 2/3 would be replaced by a low-copper formula. We assumed that all low- and no-copper formulas would remain the same.

Ecology believes these are conservative assumptions. Many brake manufacturers have informed Ecology that they will replace high-copper formulas with no-copper formulas due to California requirement that takes effect in 2025 that requires brakes contain less than 0.5 percent copper and the possibility that Washington may implement similar requirements. It is likely not cost-effective to reformulate a product twice. It is also likely that many low-copper formulas will be replaced with no-copper formulations.

Using these assumptions, Ecology calculated the following estimates for the amount of copper that will be released from brakes manufactured in 2021. This is a nearly 90 percent copper reduction by 2021.

Estimated Copper Released from Brakes Manufactured During 2021

	Copper Released (kg/yr)
Statewide	15,000
Puget Sound	10,000

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Appendices

Appendix A

Washington State Transportation Data

HPMS Miles and VMT by County

June 15, 2012

Information is from the **2011** HPMS data system and includes all public roads excluding ramps

	Federal	Local Access (FC 9 & 19)		Total (All Public Roads)			
County Name	County Number	Centerline Miles	Lane Miles	Centerline Miles	Lane Miles	Daily VMT	Annual VMT (in 1000s)
ADAMS	1	1638.94	3,278	2,559.32	5,282	1,342,875	490,149
ASOTIN	3	353.24	706	613.92	1,232	257,852	94,116
BENTON	5	1438.04	2,876	2,172.44	4,607	3,989,607	1,456,207
CHELAN	7	1907.32	3,815	2,355.81	4,768	1,660,629	606,130
CLALLAM	9	863.23	1,726	1,293.82	2,609	1,455,289	531,180
CLARK	11	2073.15	4,146	2,852.22	6,024	7,717,108	2,816,744
COLUMBIA	13	566.76	1,134	845.42	1,693	146,804	53,584
COWLITZ	15	717.59	1,435	1,197.31	2,579	3,295,266	1,202,772
DOUGLAS	17	2427.12	4,854	3,103.53	6,219	921,343	336,290
FERRY	19	1409.70	2,819	1,802.08	3,604	246,529	89,983
FRANKLIN	21	1233.64	2,467	1,789.37	3,727	1,825,344	666,251
GARFIELD	23	286.29	573	559.92	1,120	152,809	55,775
GRANT	25	2299.60	4,599	3,653.62	7,472	2,675,746	976,647
GRAYS HARBOR	27	1061.50	2,123	1,682.27	3,433	1,878,717	685,732
ISLAND	29	1089.29	2,179	1,391.35	2,788	1,200,267	438,097
JEFFERSON	31	596.00	1,192	903.03	1,806	902,473	329,402
KING	33	5678.63	11,357	7,920.69	17,533	45,385,096	16,565,560
KITSAP	35	1403.64	2,807	1,921.66	3,961	4,677,312	1,707,219
KITTITAS	37	1091.21	2,182	1,632.51	3,479	3,025,899	1,104,453
KLICKITAT	39	907.60	1,815	1,483.32	2,967	613,974	224,100
LEWIS	41	1064.88	2,130	1,704.80	3,482	2,982,496	1,088,611
LINCOLN	43	1540.13	3,080	2,485.88	5,004	733,335	267,667
MASON	45	560.52	1,121	973.45	1,963	1,314,000	479,610
OKANOGAN	47	2497.03	4,994	3,435.88	6,872	1,203,658	439,335
PACIFIC	49	429.19	858	740.97	1,484	582,137	212,480
PEND OREILLE	51	1255.12	2,510	1,555.18	3,122	306,566	111,897

	Federal	Local Access (FC 9 & 19)		Total (All Public Roads)			
County Name	County Number	Centerline Miles	Lane Miles	Centerline Miles	Lane Miles	Daily VMT	Annual VMT (in 1000s)
PIERCE	53	3198.61	6,397	4,690.14	10,019	17,474,809	6,378,305
SAN JUAN	55	265.17	530	355.79	712	144,164	52,620
SKAGIT	57	949.58	1,899	1,594.51	3,299	3,728,942	1,361,064
SKAMANIA	59	358.75	717	620.73	1,241	339,882	124,057
SNOHOMISH	61	3324.97	6,650	4,443.76	9,366	15,347,544	5,601,854
SPOKANE	63	3293.99	6,588	4,752.00	10,036	9,690,379	3,536,988
STEVENS	65	1504.70	3,009	2,328.68	4,659	912,969	333,234
THURSTON	67	1186.34	2,373	1,792.86	3,833	6,379,670	2,328,580
WAHKIAKUM	69	62.54	125	186.01	372	104,775	38,243
WALLA WALLA	71	676.12	1,352	1,336.55	2,742	1,246,141	454,841
WHATCOM	73	1177.62	2,355	1,881.46	3,875	4,269,098	1,558,221
WHITMAN	75	1524.36	3,049	2,453.23	4,928	1,017,765	371,484
YAKIMA	77	3442.46	6,885	4,677.52	9,642	4,919,738	1,795,704
TOTAL		**57,354.57**	**114,709**	**83,743.01**	**173,555**	**156,069,006**	**56,965,187**

Travel Activity by Vehicle Type

2011 **Percent of Travel (in %)** **7/9/2012**

Rural / Urban	Functional System	Motor Cycles	Passenger Car (2 Axle, 4 Tire)	Light Trucks (2 Axle, 4 Tire)	Buses	Single-Unit Trucks	Combination Trucks	Total
Rural	Interstate	**0.22**	**58.10**	**23.44**	**0.32**	**5.41**	**12.51**	**100.000**
Rural	Other Arterial	**0.51**	**58.53**	**28.10**	**0.28**	**6.84**	**5.74**	**100.000**
Rural	Other Rural	**1.28**	**53.75**	**31.45**	**0.26**	**7.95**	**5.31**	**100.000**
Urban	Interstate	**0.26**	**66.63**	**23.98**	**0.25**	**4.07**	**4.81**	**100.000**
Urban	Other Arterial	**0.32**	**66.54**	**25.47**	**0.25**	**4.93**	**2.50**	**100.000**
Urban	Other Urban	**0.40**	**62.45**	**29.77**	**0.21**	**4.76**	**2.42**	**100.000**
Total	**All**	**0.35**	**63.76**	**25.58**	**0.26**	**4.73**	**5.33**	**100.000**

Appendix B

List of Manufacturers Reporting (as of 6/20/13)

Manufacturer Name
ABS Friction Inc.
Advics North America, Inc.
AKEBONO Corporation
Bosch Brake Components LLC
Brake Parts Inc., LLC
Brembo North America
China Yantai Friction Co., Ltd.
Danaher Auto Spare Parts Co., Ltd.
Dongying Xinyi Automobile Fitting Co., Ltd.
European Friction Industries, Ltd.
FDP Virginia Inc.
Federal-Mogul
FRAS-LE North America, INC.
FRENOSA
Friction Materials LLC (Honeywell)
Hitachi Chemical Co. America, Ltd.
Icer Brakes S.A
ITT
Jinan Gold Phoenix Brake Systems Co., Ltd.
New World Friction
Nisshinbo Automotive Manufacturing Inc.
OE Quality Friction
Performance Friction
Pujiang Winsafe Friction Material Co., Ltd
REMSA of America
Roulunds Breaking ApS
Ruiyang Automotive Materials Co., Ltd.
SAERON Automotive (Beijing) Co., Ltd.
SAERON Automotive Co., Ltd.
Shandong Gold Phoenix Co., Ltd.
TEK-MOTIVE, Inc
TMD Friction
Yantai Hi-Pad Break Technology Co., Ltd